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AUSTRALIA

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PROVISIONAL SPECIFICATION

Applicant(s):

TECHNOLOGICAL RESOURCES PTY LIMITED

A.C.N. 002 183 557

Invention Title:

METHOD OF BUILDING A DIRECT SMELTING PLANT

The invention is described in the following statement:

METHOD OF BUILDING A DIRECT SMELTING PLANT

The present invention relates to direct smelting plant for producing molten metal in pure or alloy form from a metalliferous feed material such as ores, partly reduced ores and metal-containing waste streams.

A known direct smelting process, which relies principally on a molten metal layer as a reaction medium, and is generally referred to as the HIsmelt process, is described in International Patent Publication WO 96/31627 (International Patent Application PCT/AU96/00197) in the name of the applicant. The HIsmelt process as described in the International application comprises:

(a) forming a bath of molten iron and slag in a vessel;
(b) injecting into the bath:
  (i) a metalliferous feed material, typically metal oxides; and
  (ii) a solid carbonaceous material, typically coal, which acts as a reductant of the metal oxides and a source of energy; and
(c) smelting metalliferous feed material to metal in the metal layer.

The term "smelting" is herein understood to mean thermal processing wherein chemical reactions that reduce metal oxides take place to produce liquid metal.

The HIsmelt process also comprises post-combusting reaction gases, such as CO and H_2 released from the bath in the space above the bath with oxygen-containing gas and transferring the heat generated by the post-combustion to the bath to contribute to the thermal energy required to smelt the metalliferous feed materials.

The HIsmelt process also comprises forming a transition zone above the nominal quiescent surface of the bath in which there is a favourable mass of ascending and thereafter descending droplets or splashes or streams of

molten metal and/or slag which provide an effective medium to transfer to the bath the thermal energy generated by post-combusting reaction gases above the bath.

In the HIsmelt process the metalliferous feed material and solid carbonaceous material is injected into the metal layer through a number of lances/tuyeres which are inclined to the vertical so as to extend downwardly and inwardly through the side wall of the smelting vessel and into the lower region of the vessel so as to deliver the solids material into the metal layer in the bottom of the vessel. To promote the post combustion of reaction gases in the upper part of the vessel, a blast of hot air, which may be oxygen enriched, is injected into the upper region of the vessel through the downwardly extending hot air injection lance. Offgases resulting from the post-combustion of reaction gases in the vessel are taken away from the upper part of the vessel through an offgas duct.

The HIsmelt process enables large quantities of molten metal to be produced by direct smelting in a single compact vessel. However, in order to achieve this it is necessary to transport hot gases to and from the vessel, to transport the metalliferous feed material to the vessel and to transport the molten metal product and slag away from the vessel all within a relatively confined area. This requires the installation of various major ancillary components in the plant. For example, there will generally be gas heating stoves and ducting for supply of heated input gas to the vessel; solids feed equipment for feeding ore and coal to the vessel which equipment may include apparatus for pre-heating the ore; offgas ducting and offgas treatment apparatus such as offgas scrubbing and demisting apparatus and molten metal and slag tapping and handling equipment. All of these components must operate continuously through a smelting operation which can be extended over a long period and it is necessary to provide for access to the vessel and ancillary components for maintenance and lifting of equipment between smelting operations.

Building a direct smelting plant of the kind described above presents major problems in that it is necessary to erect various kinds of major equipment sourced from different manufacturers at a single site area. The present invention facilitates offsite prefabrication and assembly of the major plant components which components can then be transported to the site and lifted into position in less time and with less people on site than has been possible with conventional erection of each of the components on site.

The invention may employ a ringer crane of a kind in which a boom carrying crane carriage is supported on a ring track and which carries one or more counter weights to counter the load to be lifted. A crane of this kind is flexible in operation in that it can lift relatively small or large loads with minimum adjustment or change to the crane structure.

The invention may provide a method of building a direct smelting plant comprising:

locating a ring track of a ringer crane on a plant site such that a lifting boom of the ringer crane can sweep a ground area about the ringer track;

installing a metal smelting vessel and ancillary plant components within said swept ground area by lifting with the crane the vessel and ancillary plant components either as prefabricated whole units or in prefabricated pieces into locations within the swept ground area, but so as to leave an elongate corridor of vacant ground extending through the swept area to the ring track;

lowering the boom down into the corridor; and

dismantling and removing the ringer crane and leaving at least part of the corridor available for vehicular access to the metal smelting vessel.

Substantially all or a major part of the corridor may be left available for vehicular access to the smelting vessel and at least some of said auxiliary components.

The ring track of the ringer crane may be a circular track and may be spanned by a crane carriage

including diametrically across and rotatable about a central vertical axis.

The boom of the crane may in use be attached to the carriage at one side of the carriage generally above the track and the crane counterweight or counterweights may be supported on the carriage generally over the track at or toward an opposite side of the carriage.

The major plant components may comprise any one or more of vessel input gas heaters and ducting, vessel input solids feed apparatus, offgas ducting and treatment apparatus; and molten metal and slag tapping and handling apparatus.

At least some of the ancillary plant components may be positioned at locations spaced along the corridor. More specifically, they may be positioned generally in rows spaced to either side of the corridor.

The reduction vessel may be positioned at an end of the corridor.

More particularly, the reduction vessel may be initially located adjacent the crane ring track in alignment with the corridor and at least some of the ancillary plant components located generally in rows extending from the reducing vessel along and to either side of the corridor.

The crane may be assembled initially by laying the boom out along the ground which is to form the corridor and then erecting the boom to extend upwardly from the ring track.

The vessel and major plant components may then be transported to the corridor area and lifted from that area by the crane into said locations.

In order that the invention may be more fully explained, one particular embodiment will be described in some detail with reference to the accompanying drawings in which:

Figures 1A, and 1B join on the lines A-A to form a diagrammatic perspective view of a direct smelting plant to be built in accordance with the present invention;

Figure 2 is a diagrammatic flow sheet showing the overall operation of the plant;

Figure 3 is a detailed view of a reduction vessel and offgas handling facilities incorporated in the plant;

Figure 4 is a prospective view of a ringer crane;

Figure 5 is a diagrammatic plan of a central part of the plant site showing the position of the ringer crane;

Figure 6 and 7 show the crane in operation to hoist a section of a smelting vessel into position on the site.

The illustrated direct smelting plant comprises a direct smelting vessel 11 suitable for operation by the HIsmelt process as described in International Patent Publication WO 96/31627. Vessel 11 has a hearth that includes a base 12 and sides 13 formed from refractory bricks; side walls 14 which form a generally cylindrical barrel extending upwardly from the sides 13 of the hearth and upper barrel section 15; a roof 16 an outlet 17 for offgases; a forehearth 18 for discharging molten metal continuously; and a tap hole 19 for discharging molten slag.

Vessel 11 is fitted with a downwardly extending gas injection lance 21 for delivering a hot air blast into the upper region of the vessel and eight solids injection lances 22 extending downwardly and inwardly through the side walls for injecting iron ore, solid carbonaceous material and fluxes entrained in an oxygen deficient carrier gas into the bottom part of the vessel.

Gas injection lance 21 receives an oxygen enriched hot air flow through a hot gas delivery duct 23 that extends from a hot gas supply station denoted generally as 24 which is located on the plant site in the vicinity of the reduction vessel 11. The hot gas supply station 24 incorporates a series of hot gas stoves 25, 26 that receive oxygen from an oxygen plant 27 and air under pressure from a blower. This enables an oxygen enriched air stream to be passed through the hot gas stoves and into the elevated hot gas delivery duct 23 which extends

to a connection with the gas injection lance 21 at a location above the reduction vessel 11.

The offgas outlet 17 is connected to an offgas duct 31 which transports the offgas away from the reduction vessel 11 to a treatment station 32 located on the plant site a short distance away from the reduction vessel 11 and generally to the opposite side of that vessel from the hot gas supply station 24. The offgas treatment station includes an offgas hood 33 of inverted U-shaped formation extending well above the height vessel 11 and incorporating pressure relief valves 34 and a hooded steam drum 35 at its upper end. The offgas passes upwardly and then downwardly through hood 33 to an offgas scrubber 36 and demister 37 installed as part of the offgas treatment station 32.

The solids injection lances 22 receive hot ore injection and coal and flux injection from a solids injection station 41 installed on the plant site at a location spaced from the reduction vessel 11 and generally to the same side of that vessel as the offgas treatment station 32. The solids injection station 41 includes ore fluidising hoppers 42, and pre-heater 43 through which the hot ore is fluidised for delivery through a pipe 44 to the respective ore injection lances 22 into vessel 11. Solids delivery station 41 also includes coal and flux delivery and fluidising hoppers 45, 46 to produce a flow of coal and flux to the remaining solids injection lances 22.

Hot metal is continuously tapped from vessel 11 through forehearth 18 and flows through appropriate launders to ladles which are transferred to hot metal desulphurisation station 47 installed on the plant site at a location adjacent the metal delivery vessel and generally on the same side of that vessel as the hot air delivery station 24. After desulphursation at station 47, the hot metal is delivered in the ladles to pig casters 48.

Slag continuously tapped from vessel 11 flows through slag launders to slag pits located behind vessel

11 and generally between the solids injection station and the hot metal desulphurisation station.

In a full scale production plant as illustrated, the direct smelting vessel and the ancillary components are of extremely large size and weight in the finished construction. Indeed, several of the ancillary components such as the stoves and the offgas hood and scrubbers are very tall and are much larger than the reduction vessel itself. The normal method of building such a large scale plant would be to build the vessel and each of the ancillary components at the various stations from the ground up on site requiring large teams of people to work on the site at the same time with complicated delivery schedules and quality control of problems. The present invention enables not only the direct smelting vessel but the major ancillary components of the plant to be fabricated offsite and lifted into position in a relatively rapid installation process.

The installation process involves the use of a ringer crane 51 comprising a crane carriage 52 supported on a circular ring track 53. A crane boom 54 is attached to the crane carriage and can be hoisted by operation of a winch 55 to lift a heavy load 56 (such as a bottom section of the metal reduction vessel 11), the weight of that load being counteracted by counterweights or ballast 57 mounted on the carriage so as to also be supported on the ring track 52.

The ring track of ringer crane 51 is firstly installed on the plant site immediately in front of the location at which the metal reduction vessel 11 is to be installed. The boom 56 is then brought onto site and laid out along an elongate stretch of the site which is to become a corridor between major ancillary components at the various stations of the plant when the plant is fully erected. The boom is then connected to the carriage and hoisted so as to provide a high lift capacity over a ground area which the ringer crane can sweep about the ringer track.

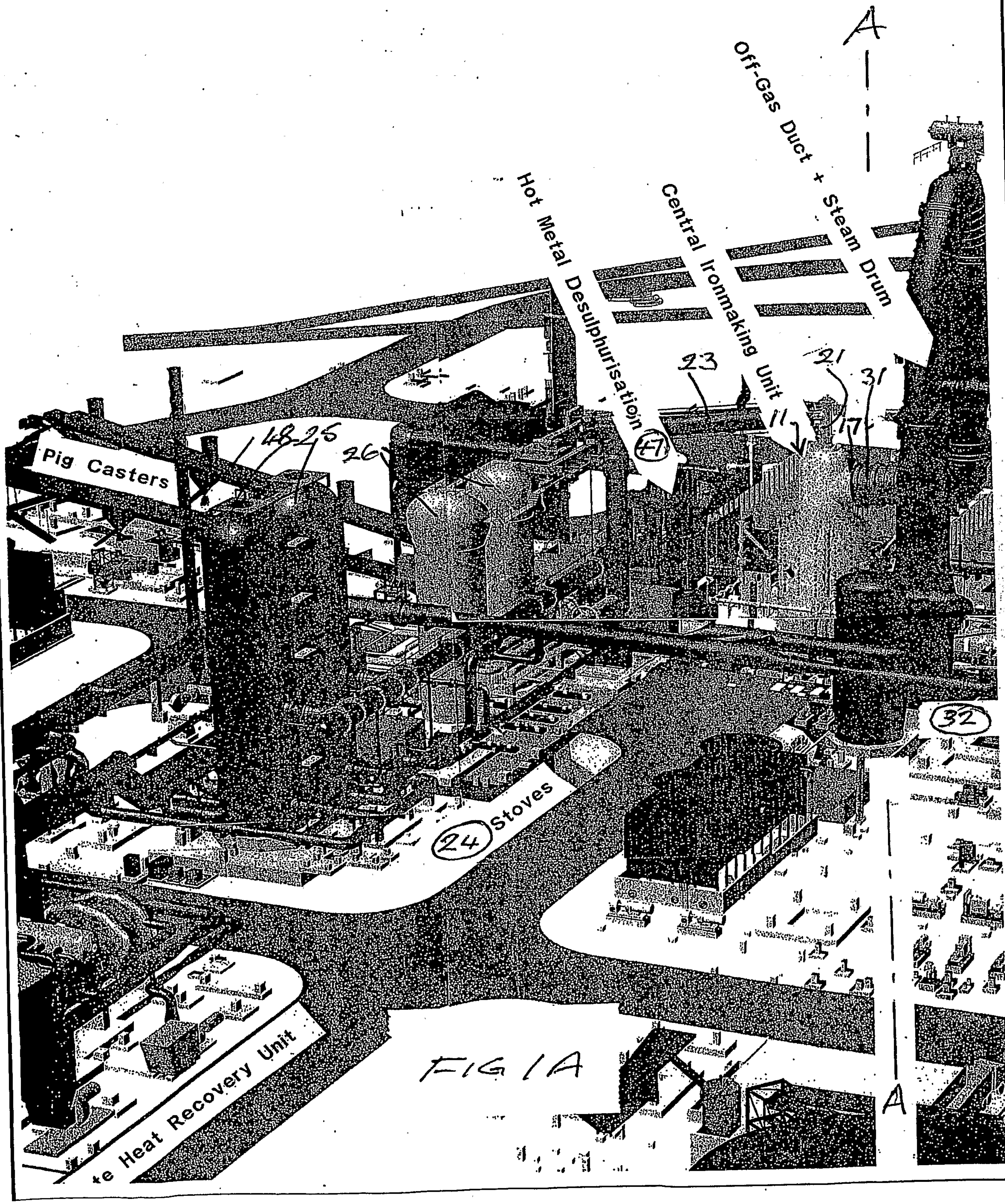
The ground area swept by the crane is such as to embrace the proposed sites of the smelting vessel 11 and major ancillary components, such as those in the hot air supply station 24, the offgas treatment station 32, the solids feed station 41, the hot metal desulphurisation station 47 and also the hot metal and slag launders extending from the smelting reduction vessel. Prefabricated components are then brought onto site and lifted by the ringer crane, typically from the corridor into the appropriate positions for final installation and connection with the remainder of the plant. Because of the high lift capacity of the ringer crane, it is possible to build permanent housings, building structures and bridges which are to house or extend between the various major components of the plant prior to the installation of those components and then merely lift the relevant components and deposit them downwardly through these surrounding structures into final position. For example, the reduction vessel may in the final installation be surrounded by a frame work structure carrying walkways and cooling water manifolds for flow of cooling water to and from cooling panels located within the vessel. This structure can be erected initially with an open top and the reduction vessel installed by hoisting it downwardly into the surrounding structure.

Depending on the lifting capacity of the crane, it will generally be necessary to install the reduction vessel and some other components in a number of pieces or sections. For example, the ringer crane may be of a type having a lift capacity rating of the order of six hundred tonnes. Typically, such a crane would be capable of lifting in the order of two hundred tonnes at a radius of approximately 50 meters from the ring track. As a result, the reduction vessel may need to be fabricated in three sections to be hoisted successfully into place in order to remain within this lift capacity. Similarly, the stoves 25, 26 may need to be made in two or more sections to remain within the maximum lift capacity of the crane. Nevertheless, all of the ancillary components can be

largely fabricated offsite with consequent better quality control and inspection and with very significant savings in onsite manpower during the plant installation.

The vessel and ancillary components are installed to leave the elongate corridor 60 of vacant ground extending through the swept area of the crane to the ring track. When the crane is not being used during extended installation or during periods of high wind, the crane boom 54 may be lowered down to lie on the ground along that corridor. When installation of the vessel and the various ancillary components has been completed, the boom is laid down along the corridor and the crane is dismantled and removed, leaving the corridor as a lane way providing access to the vessel and to the various ancillary components, for example, by mobile cranes.

The illustrated direct smelting plant has been advanced by way of example only. It is to be understood that the particular layout of that plant could be varied and the kinds of ancillary equipment could also vary considerably according to the materials and fuels available for smelting. It is to be understood that such variations can be made without departing from the scope of the invention to be protected.



A
Off-Gas Duct + Steam Drum
Central Ironmaking Unit
Hot Metal Desulphurisation
47
23
21
31
11
17
48
25
26
Pig Casters
32
24
Stoves
Heat Recovery Unit
A

FIG 1A

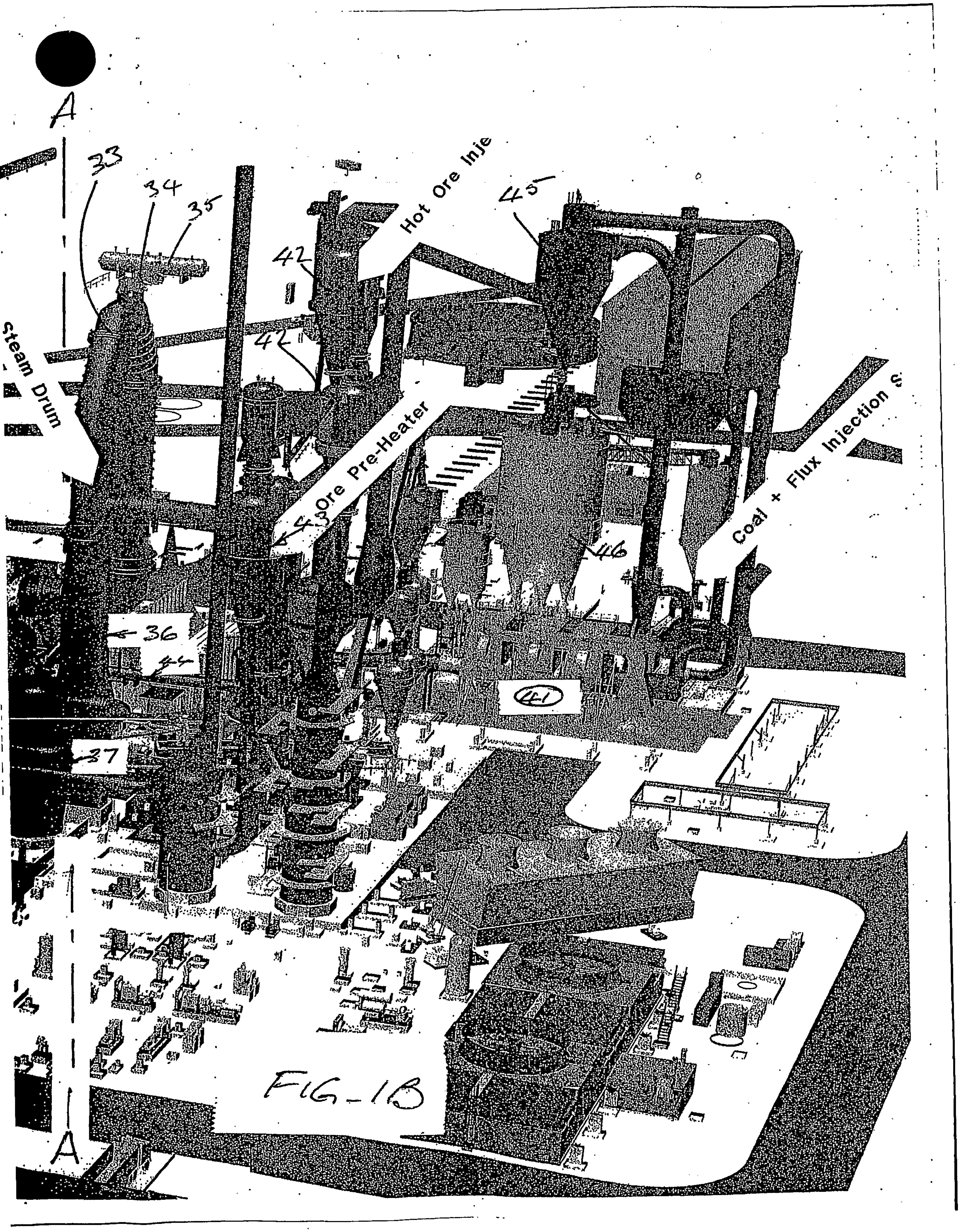

A
33
34
35
Steam Drum
42
42''
Hot Ore Inje
45
Ore Pre-Heater
43
Coal + Flux Injection
46
36
44
41
37
A

FIG_1B

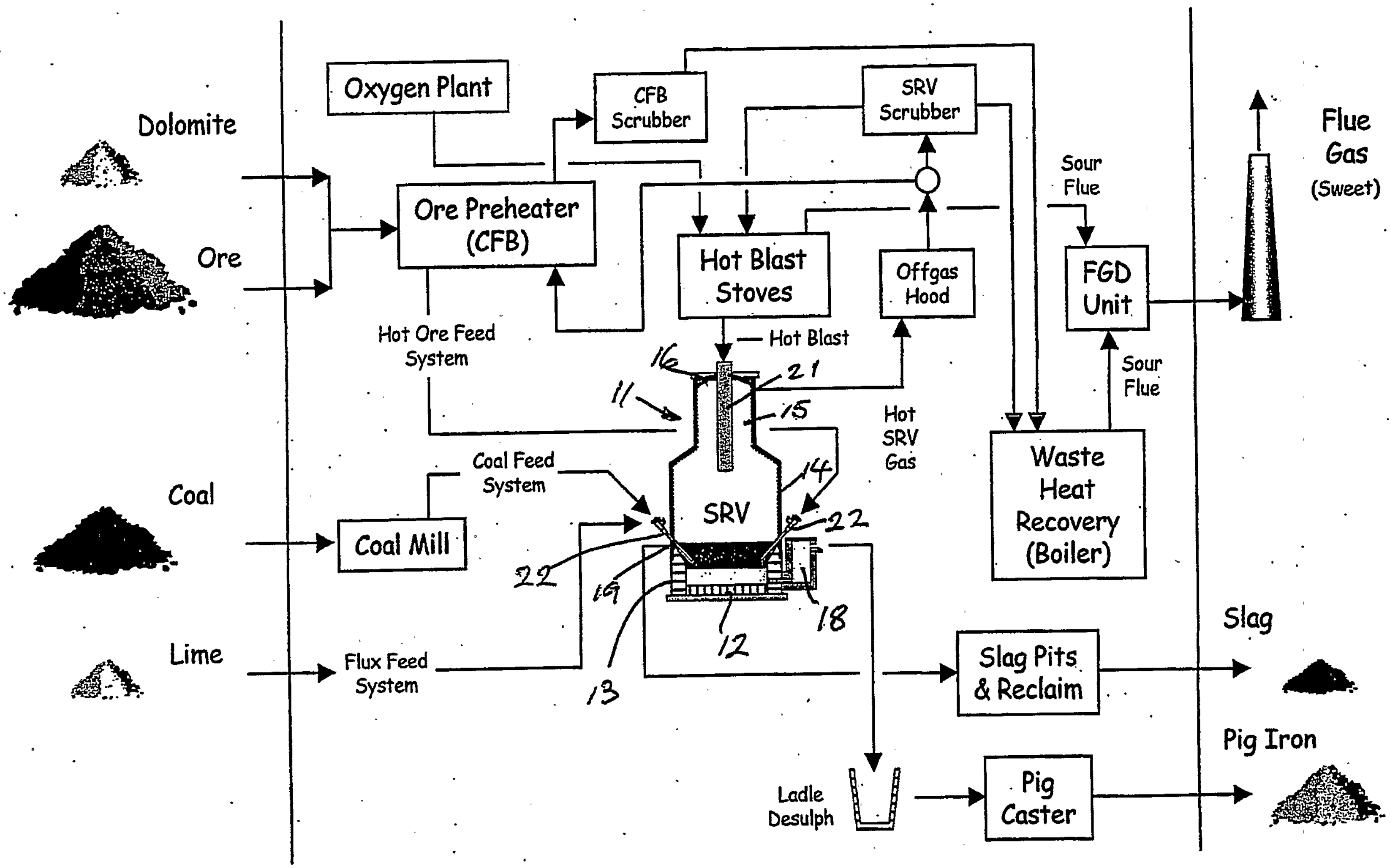

Dolomite
Ore
Coal
Lime
Oxygen Plant
Ore Preheater (CFB)
CFB Scrubber
SRV Scrubber
Hot Blast Stoves
Offgas Hood
Sour Flue
FGD Unit
Flue Gas (Sweet)
Hot Ore Feed System
Hot Blast
Hot SRV Gas
Sour Flue
Waste Heat Recovery (Boiler)
Coal Feed System
Coal Mill
SRV
Flux Feed System
Slag Pits & Reclaim
Slag
Ladle Desulph
Pig Caster
Pig Iron
11
12
13
14
15
16
18
19
21
22
22

FIG_2_

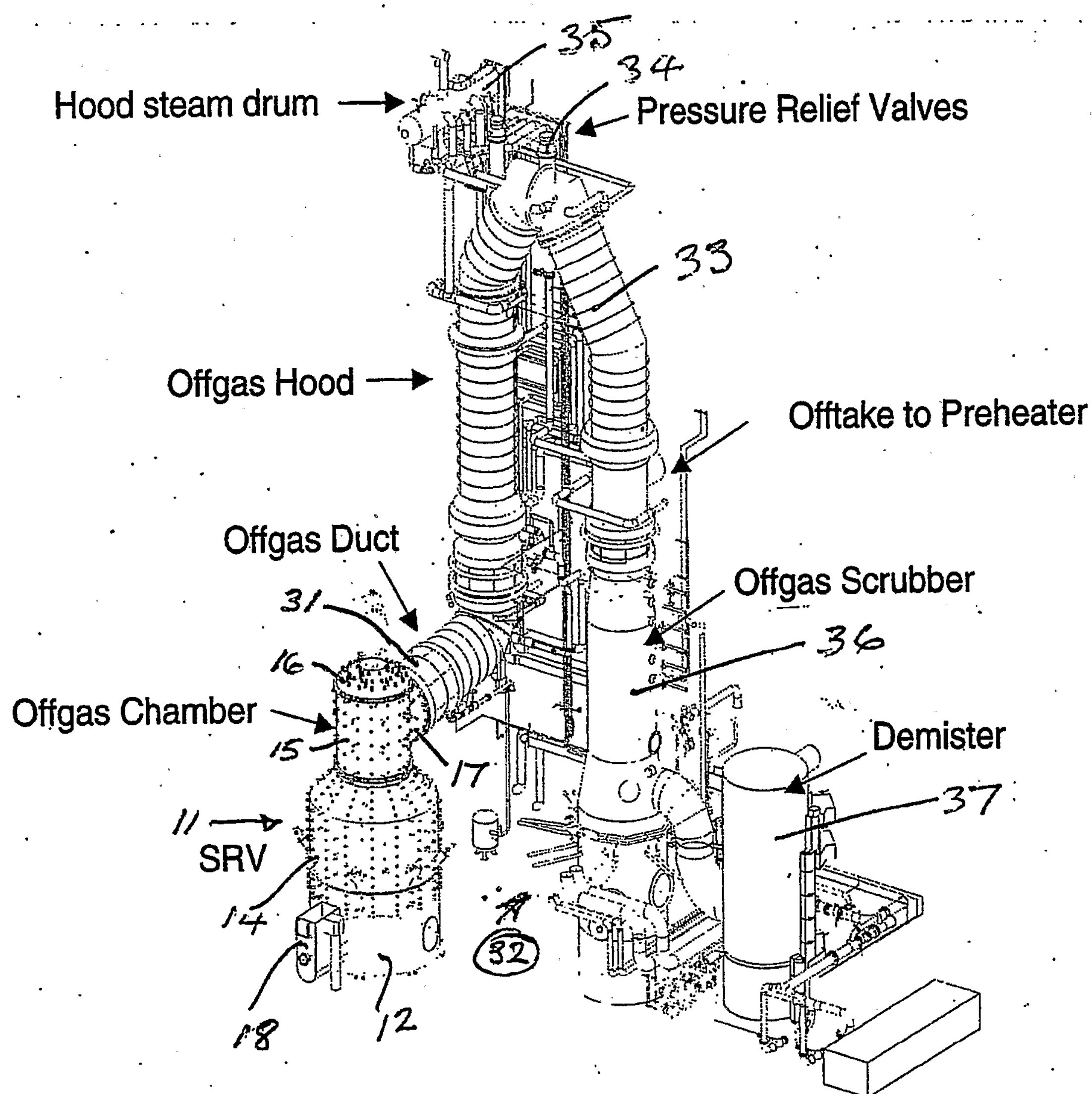

Hood steam drum
35
34
Pressure Relief Valves
33
Offgas Hood
Offtake to Preheater
Offgas Duct
31
Offgas Scrubber
36
16
Offgas Chamber
15
17
Demister
37
11
SRV
14
32
18
12

FIG. 3

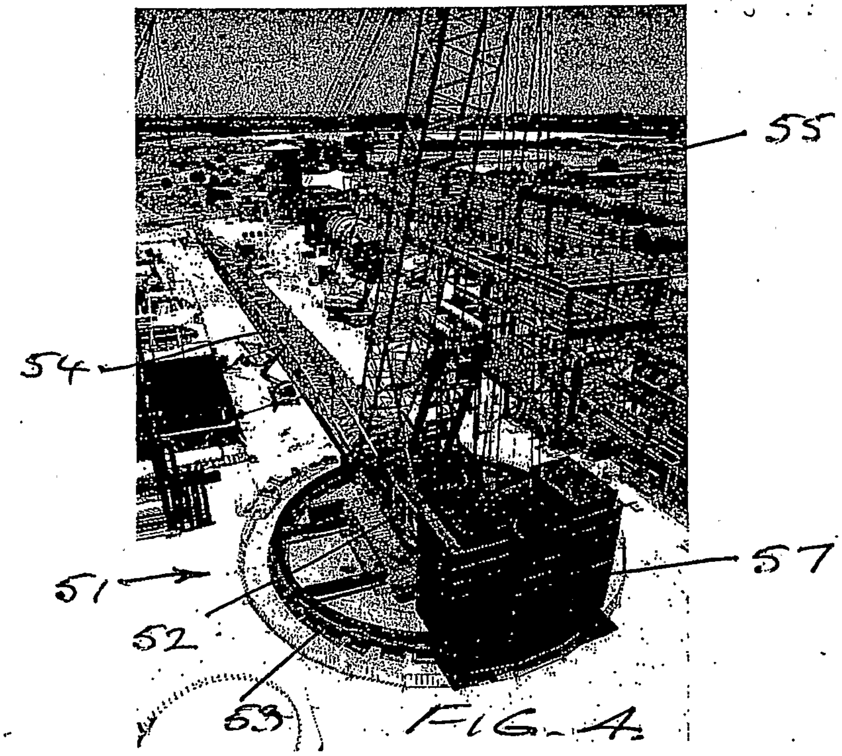


FIG. 4.

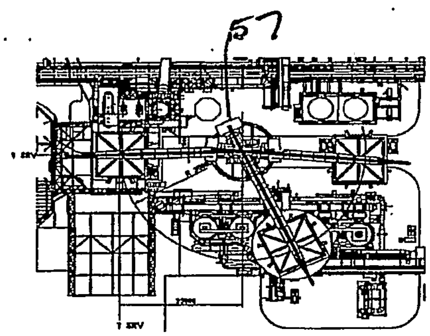


FIG 5

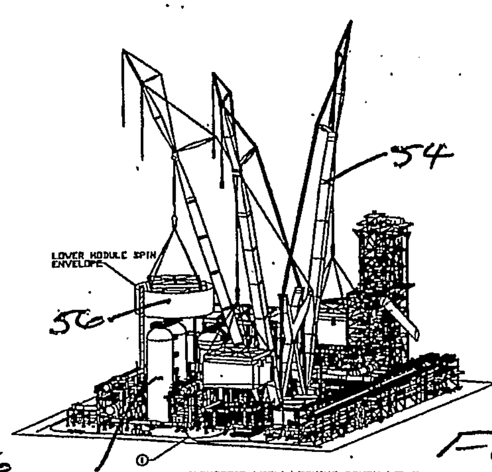


FIG 6

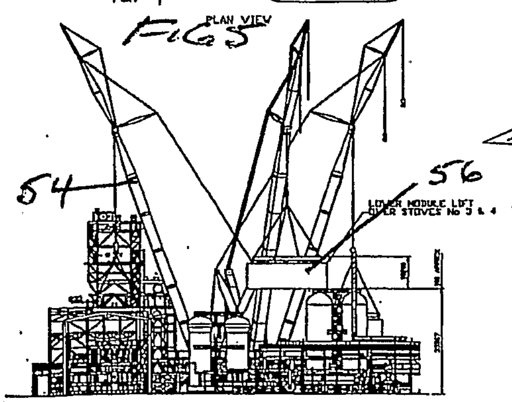


FIG 7